

## Notes from Photoscan workshop, Denver, CO, 29 Jan. – 3 Feb. 2017, version 1.2.6

If you have photos with GPS in exif – do the alignment and immediately if you have GCP add these. Put the markers in the right position going through the photos. Select all photos (In Reference – Cameras pane) and **uncheck** them and **keep check only the GCP** (Reference – markers pane) and do a new alignment. Now the sparse pcloud will try to accommodate the best the GCPs that have GPS cords much better than camera GPS. Make sure you add in preferences (the cross hammer icon) the correct accuracy for markers – that means GCP). For Majuro 0.05 m is a good value (GPS RTK points have an accuracy of 1 to 3 cm most of the time).

**Error elimination:** - make sure only the GCP (markers) are checked and the photos are unchecked).

1.

Gradual Selection -> **Reconstruction Uncertainty** -> Level **10** (or successive smaller levels until i can get 10) -> Delete Points -> Optimize = do that until level 10 will select no new points. Don't delete more than 10 to 20 % of the points at once .... This is an iterative and quite slow process actually.

The level 10 is empirically derived. Points with level > 10 have bad geometry, if level > 10 = bumpy surface. If you cannot obtain points less than level 10, then make sure you are at least below 50, and as close to 10 as possible. It may be possible to first delete points with levels >10 and gradually try to lower the level towards 10. Reconstruction uncertainty refers to "good geometry".

Monitor the photos with the min. no. of tie points. If that photo is blurry you can delete it. Usually Photoscan does not use photos with less than 100 tie points for dense pclouds or mesh, or photos with min no. of points less than 10% of max. no. of tie points for a photo. Don't get rid of photos with low tie points if they are not blurry.

2.

Gradual Selection -> **Projection Accuracy** -> Level **2** (or between 6 and 2) -> Delete points -> Optimize = do that until the lowest level you want to stop at does not select any more points. Usually you have to lower the level slowly so you don't delete more than 10 or 20% (max) of the points at once. Do this multiple times.

The projection Accuracy is a measure of the relative assessment of the tie points accuracy relative to the best points. When the Optimization is done a weighted RMSE in pixel value is reported and depends on the pixel size and quality. The "level x number" means that the points have uncertainly x times more than the points of level 1. Not all projects will tolerate to decrease the level to 2 or 3 .... Especially if you have only jpg photos due to compression only a level of 5 or 6 may be the best that can be obtained. Projection accuracy is not influenced by camera calibration.

3.

Gradual Selection -> **Reprojection Error** -> level: 0.3 if the selected points are less than 10% of total points remaining or 10% of total points even if the level is >0.3. Do not go below 0.3 even if 10% is not reached. Delete the selected points and Optimize. Repeat until 0.3 selects no more points. Make sure in Optimization you have all camera params selected to be refined.

Reprojection error means how far we are if we use the tie points and try to reconstruct back camera positions – how far away are we from the original camera position we have when we obtained the tie points. Level 0.3 means we are 0.3 pixels away from the "real" position

### **Final optimization feedback**

Console pane – results of optimization – 'xxxxx' represent number of iterations required to minimize errors, followed by the beginning and end of Standard Error of Unit Weight (SEUW) or weighted RMSE (?). If the error estimate for the tie points is changed from 1 to 0.1 then the SEUW should be close to 1 indicating that adjusted error is closer to estimated error (is what we want), and results are more likely to be statistically valid. The RMS reprojection error, weighted, is very close to 0.1 pixel.

After error elimination it seems i remain with about 10 to 20% of the total points of the initial sparse point cloud, but these points have the best geometry i can obtain from the photos.

Phantom 4 does not have a very good sensor, and the fact that the photos are jpg only – this introduces even more errors / distortions. The lens distortion plot is asymmetrical having a squished ellipse shape. Also the lens has rolling shutter (we prefer global shutter to introduce less distortion) and Photoscan 1.2.6 does not compensate for that. Supposedly the next version when it will be stable 1.3 will try to compensate for that.

### **Error limits for Phantom 4 – camera is not calibrated**

- Reconstruction Uncertainty – Level 10 should not select any more points
- Projection Accuracy – Level 5 or less should not select any more points
- Reprojection Error – Level 0.3 should not select any more points.